

IMPROVE GASOLINE OCTANE NUMBER AND STUDYING REID VAPOR PRESSURE EFFECT AND CALORIFIC VALUE BY USING ENVIRONMENTAL ADDITIVES

HUSHAM MOHAMMED AL. TAMEEMI

Assistant. Professor, College of Engineering - University of AL-Qadissiyah, Qadissiyah, Iraq

ABSTRACT

An assessment for the addition of DO and DOA on the octane number and Reid vapor pressure (RVP) of gasoline with different chemical compositions. The locally produced gasoline was blended with three different ratios (v/v) of the additives, i.e. 8, 10 and 15%. The octane rating of gasoline was found increasing continuously and linearly with addition of DO and DOA. The DOA-gasoline blends produced higher octane number. The two additives observed the significant decreasing of the RVP and CV of the original fractions when mixed with gasoline. However, the additives were added in 8, 10, 15%vol to gasoline blend, the increasing RON was 0.9–23.9.

KEYWORDS: Gasoline Octane, Pressure Effect, Calorific Value & Environmental Additives

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1. INTRODUCTION

Gasoline, also called petrol or gas, combination of volatile, flammable liquid hydrocarbons, that are the derivative of petroleum and used as fuel for internal combustion engines. It is also used as a solvent for fats and oils, originally a byproduct of the petroleum industry (kerosene being the main product), gasoline became the preferred vehicle fuel because of its ability to mix readily with the air in a carburetor and high energy of combustion (Ezeldin & Massad, 2015; Unnasch & Henderson, 2014). The nomenclature are shown in table 1.

Gasoline, like other hydrocarbons, does not ignite in its liquid state, as it must first evaporate and mix with oxygen to ignite (Leffler, 2008). It is the most popular product that derived from oil and forms the bulk of the product obtained per barrel of crude oil. Internal combustion engines burn gasoline in a controlled process termed as deflagration (Demirbas, Balubaid, Basahel, Ahmad, & Sheikh, 2015; Lincoln, 2000). The composition of gasoline (% volume) varies widely depending on the crude oil used and the overall balance of demand for products and refining processes (Harper & Liccione, 1995; Thomas, 1995). The typical structure of hydrocarbons in gasoline is shown in table 2.

Addition of additives to gasoline has two aims, to improve the octane number of internal combustion engines and reduce air pollution (summer fog, winter carbon monoxide, air poisoning throughout the year) with providing fuel combustion of more complete in engines (Kheiralla, El-Awad, Hassan, Hussen, & Osman, 2011; Rothamer, & Jennings, 2012; Yüksel, & Yüksel, 2004).

2. MATERIALS AND EXPERIMENTAL PROCEDURE

Materials

- Gasoline (Ref. and LSRN)
- Reformate and sweet light naphtha was obtained from Al-Daura refinery in Iraq (table 3).

- DIPE and Aniline of 99.95% purity were of analytical reagent grade and were obtained from Sigma Company.
- Olive oil was obtained from local markets.

Experimental Procedure

1-First Stage

Preparation of Gasoline Pool and Additives: the preparation of additives includes the mixing of 95% DIPE and 5% Olive Oil and mixing of 30% DIPE ,2% Olive Oil and 68% Aniline.

2-Second Stage

- Octane number and Reid vapor pressure of gasoline pool was measured by CFR engine and RVP measurement before the addition of additives.
- Three glass containers were filled with 92%, 90%, 85% of gasoline pool and add DO in different concentrations 8% ,10% and 15% to these containers and shake them by using a rod.
- Octane number and Reid vapor pressure for blends were measured.
- Repeat the 2 and 3 with DOA additives.

3. Analysis Method

The fuel properties of the blends tested have been determined in accordance with the American Standard for Testing Materials (ASTM) procedures for petroleum products (Nadim, Zack, Hoag, & Liu, 2001).

Cooperative Fuel Research Engines (CFR) (D2699) was used to determine the octane number (figure 1) and Reid vapor pressure as follows:

How to Prepare the Sample for Testing

The bottle is filled with 80% of its size and then closed, placed it in a water bath until it reaches (0°C) and then open and return to the water bath and repeat this process for three times.

Device Operation

The water bath of the device shall be filled to the mark .Turn on the device, heater and stirrer.

Method of Examination

Fill the form into the product and close it tightly and place it inside the tub, check by pressing the test button.The reading is taken from the screen corresponding to the same number for the chamber after it is constant.

The device is shown in figure 2.

4. RESULTS AND DISCUSSIONS

As we know several chemical additives have been used to improve the octane number of gasoline, but the using of natural substances as additives has not been tried so far (Mendes, Aleme, & Barbeira, 2012). In this study, olive oil was selected and mixed with other additives to improved combustion efficiency, where in the case of a gasoline combustion engine this results in both increase in fuel mileage and a decrease in harmful emissions. Where, the addition of olive oil with DIPE

reduces CO₂ emissions that increase with the addition of DIPE alone, while DIPE reduces CO emissions and hydrocarbons (Dhamodaran, Esakkimuthu, & Pochareddy, 2016; Theaker, 2011). The following study explains the effectiveness of DO and DOA on the octane number and Reid vapor pressure.

Research Octane Number

The RON values of tested gasoline blends with DO are presented in Table 4. The experimental tests started with 8% of DO and 92% of gasoline pool (shown in figure 3), it was found that the octane rating was continuously and linearly increased with a range of 0.8 of blending ratio but the increasing will be slightly down when increasing the proportion of additives up to 15% give RON equal to 79.2 (Balaban, Kier, & Joshi, 1992).

The increasing of the DOA until 15% of the blending samples are shown in table 4 and increasing RON number slightly reaching to 99.6 but at 10% it decreases to 97.5 as shown in figure 4.

Reid Vapor Pressure

The RVP values of tested gasoline blends with DO which will significantly reduce the Reid vapor pressure to 7.15 as shown in figure 5 and with DOA decreasing the RVP to 6.5 as shown in figure 6 and table 5.

Calorific Value

The results of the Calorific value in Kcal/kg (shown in table 6) were calculated theoretically.

The specific gravity of the gasoline and additives was determined using the values of the densities of the samples obtained by ASTM (D287) method. The CV values of tested gasoline blends with DO which will significantly reduce the Calorific value from 11350.32 to 11340.50 as shown in figure 7 and with DOA decreasing the CV to 11246.77 as shown in figure 8.

However, the addition of olive oil with Aniline was enhanced the octane number of the blending gasoline where this increasing is due to carbon bonds in the aniline compound tends to give an addition reactions of free oxygen radical or H free radical, OH free radical or HO₂ radicals (Seddon, 2000; Sheet, 2008).

The disadvantage of using Aniline as gasoline additive is consider as Carcinogenic and Courses hemolysis additive but blending Aniline with olive oil (which can be considered as green oil), in addition it has a high octane number and (DIPE) can led to decrease the harmful and carcinogenic emissions as results to decreasing the aniline ratio in the blending samples as shown in table 7.

5. CONCLUSIONS

- The component mixtures are used act positively to improve the octane number.
- DOA is the best prepared component mixtures for improve octane number where it rises octane number from 76 to 99.5 at concentration 8%.
- The preparation component mixtures reduce the RVP.
- RVP for gasoline after all additions with different concentration were found within the limits assigned by ASTM.
- The Calorific value of DOA is decreased that mean we get an additive that gives a characteristic similar to the fuel or better.

- Olive Oil was enhanced the Reid vapor pressure of the blending gasoline.
- The advantage of using Aniline as gasoline additive in mixture of DOA instead of pure Aniline is decreasing harmful emission on the environment and can be represent as environmentally friendly additive (Yasin, Ansari, Naqvi, & Talpur, 2008).

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APPENDIES

Table 1: Nomenclature

Symbol	Description
DO	Mixture of (Di-isopropyl Ether +Olive Oil)
DOA	Mixture of (Di-isopropyl Ether +Olive Oil + Aniline)
DIPE	Di-isopropyl Ether
RVP	Reid vapor pressure
RON	Cooperative FuelResearch
MON	Motor Octane Number
AKI.	Antiknock Index
ASTM	American Society for Testing Material
TEL	Tetraethyl lead
MTBE	Methyl Tert-Bbutyl Ether
USEPA	US Public Health Service
EDB	Ethylene Dibromide
Ref.	Reformate
LSRN	Light Straight Run Naphtha
NOx	Nitrogen Oxides
US	United States
vol	Volume
Sp.gr	Specific gravity
Add.	Additive
CV	Calorific Value
L.N	Light Naphtha
H.N	Heavy Naphtha

Table 2: Show the Typical Structure of Hydrocarbons in Gasoline in % Volume(Harper & Liccione, 1995)

The typical structure of hydrocarbons in gasoline	% volume
Alkanes	4–8
Alkenes	2–5
Isoalkanes	25–40
Cycloalkanes	3–7
Cycloalkenes	1–4
Total Aromatics	20–50
Benzene	0.5–2.5

Table 3: Show Laboratory Testing of Al-Daura Refinery Petroleum Cuts

Sample	L.N	Feed	Bottom	H.N	Reformate
Sp.Gr	83.5	64.5	64.9	60.4	52.5
RVP	17.3				6.6
Distillation					
I.B.P	32	48	54	82	44
5%	36	56	62	92	60
10%	40	66	70	98	72
20%	46	74	78	104	82
30%	54	86	89	110	94
40%	62	98	102	116	106
50%	68	108	114	124	116
60%	76	116	122	132	126
70%	84	124	128	140	134
80%	90	132	136	144	144
90%	94	144	146	148	152
95%	98	152	154	158	162
E.P	120	174	176	180	190
RON	62				90

Table 4: Show the Results of RON when Blending (DO, DOA) with Gasoline Pool

Blending Ratio	Blend Number	RON of (DO)	Blend Number	RON of (DOA)
100% gasoline + 0% Add.	1	76	1	76
92% gasoline + 8% Add.	2	76.9	5	99.5
90% gasoline + 10% Add.	3	77.5	6	97.5
85% gasoline + 15% Add.	4	79.2	7	99.6

Table 5: Show the Results of RVP when Blending (DO, DOA) with Gasoline Pool

Blending Ratio	Blend Number	RVP of (DO)	Blend Number	RVP of (DOA)
100% gasoline + 0% Add.	1	9.7	1	9.7
92% gasoline + 8% Add.	2	8.01	5	8.4
90% gasoline + 10% Add.	3	7.4	6	7
85% gasoline + 15% Add.	4	7.15	7	6.5

Table 6: Show the Results of CV when Blending (DO, DOA) with Gasoline Pool

Blending Ratio	Blend Number	CV of (DO)	Blend Number	CV of (DOA)
100% gasoline + 0% Add.	1	11350.32	1	11350.32
92% gasoline + 8% Add.	2	11345.09	5	11295.70
90% gasoline + 10% Add.	3	11343.77	6	11281.83
85% gasoline + 15% Add.	4	11340.50	7	11246.77

Table 7: Show Aniline Ratio used in (DOA) Additive in the Total Blending Sample Ratio

Blending Ratio	Aniline Ratio %
100% gasoline + 0% DOA	0
92% gasoline + 8% DOA	5.44
90% gasoline + 10% DOA	6.8
85% gasoline + 15% DOA	10.2



Figure 1: Show Research Method Test Engine.



Figure 2: Show Reid Vapor Pressure Method Test Engine.

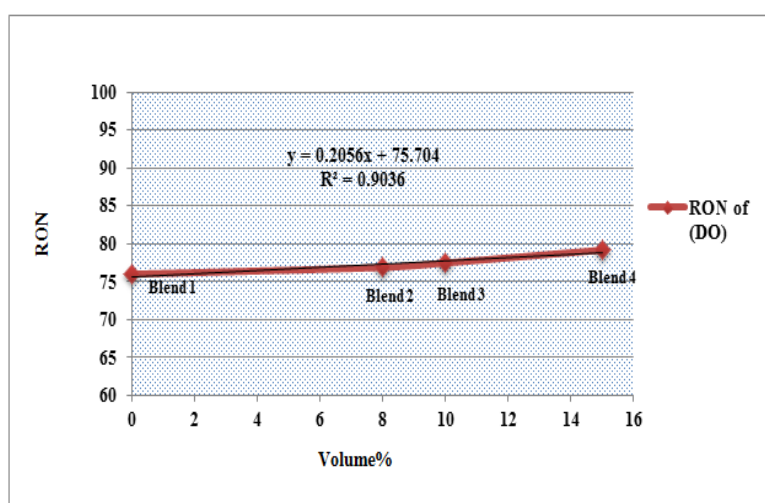


Figure 3: Show RON Value of the Gasoline with Ratio of (DO) Additive.

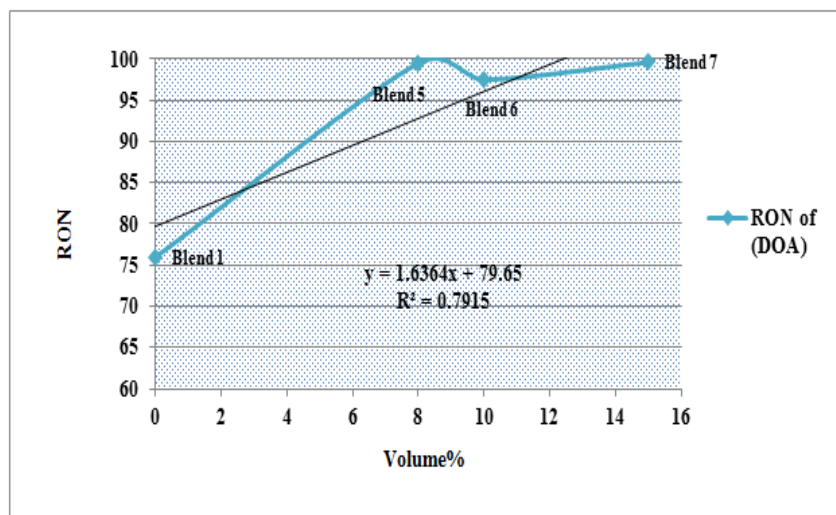


Figure 4: Show RON Value of the Gasoline with Ratio of (DOA) Additive.

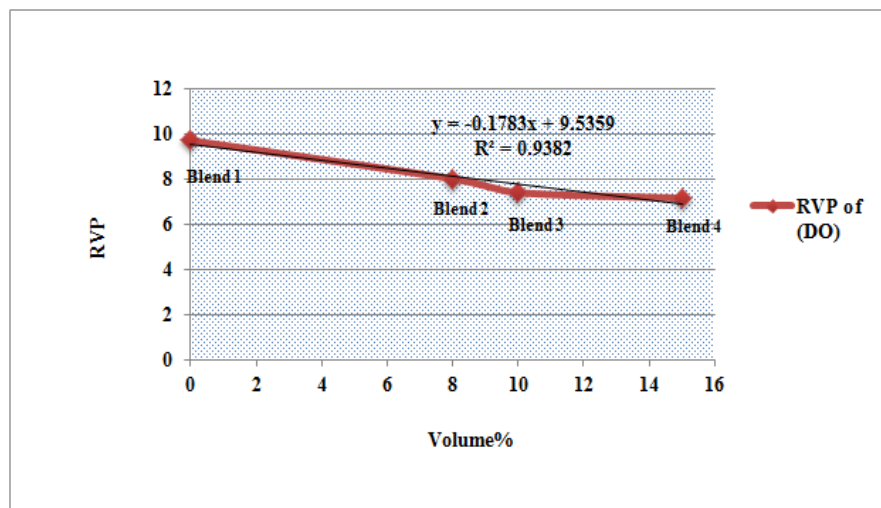


Figure 5: Show RVP Value of the Gasoline with Ratio of (DO) Additive.

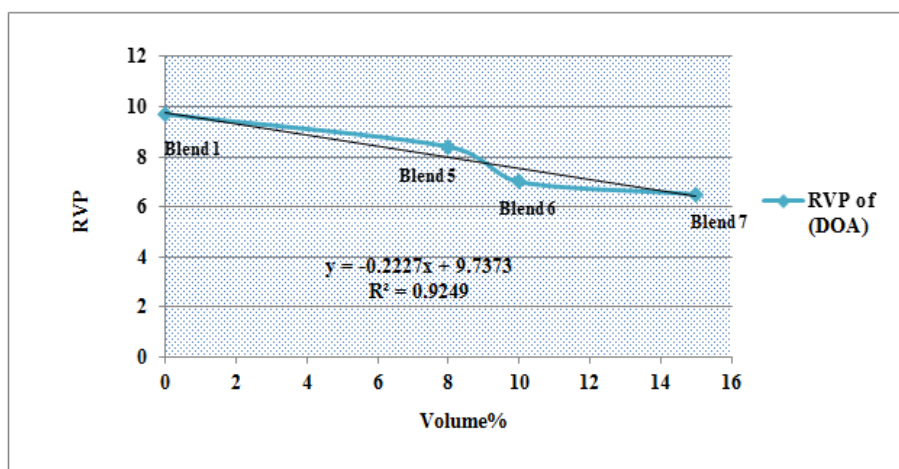


Figure 6: Show RVP Value of the Gasoline with Ratio of (DOA) Additive.

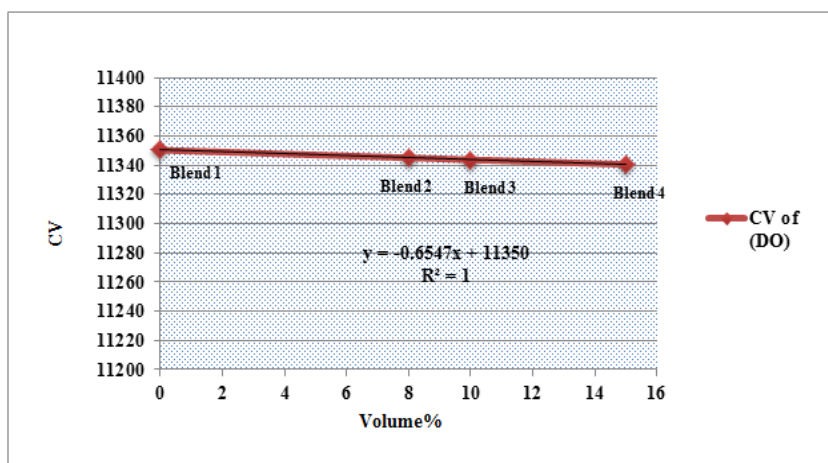


Figure 7: Show CV Value of the Gasoline with Ratio of (DO) Additive.

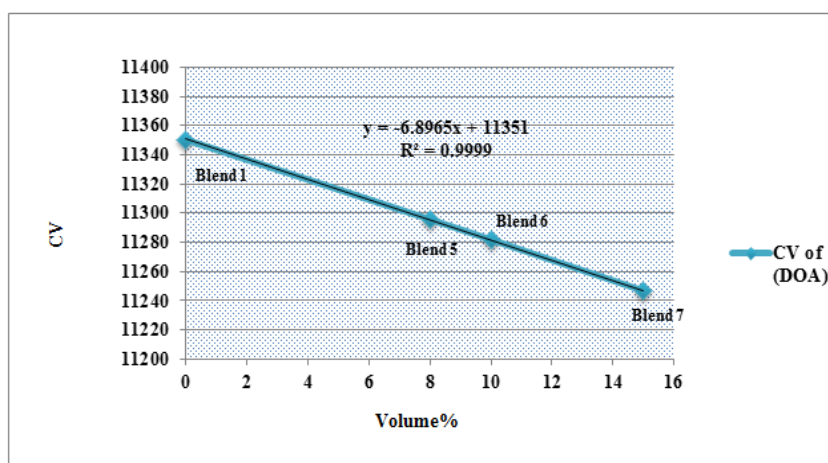


Figure 8: Show CV Value of the Gasoline with Ratio of (DOA) Additive.

